BLACKBURN
EXHIBIT H

Ericsson's mobile location solution

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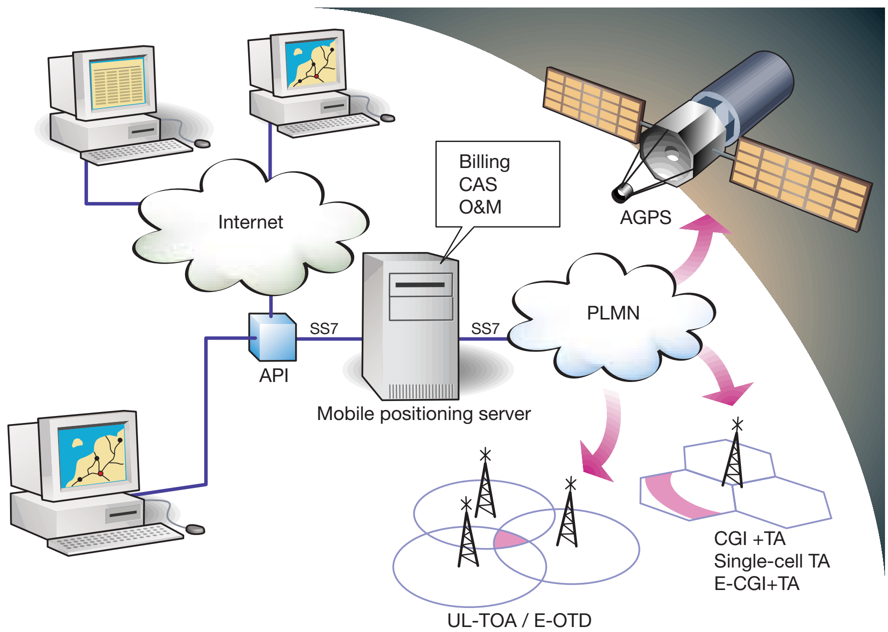
We live in a changing world. Landscapes and skylines shift as cities expand and new buildings are erected. People are also changing: over time we tend to dress differently, modify our habits, find new interests, and refine our views on music, politics, and so on. On the face of it, everything is in a state of change. Moreover, the pace at which change occurs seems to be picking up. Under the surface, however, many fundamental constants remain, oblivious to external change—the changing world of fashion preys on human vanity (a constant); and the recent shift from wired to wireless or mobile communication is indicative of mankind's as yet unfulfilled need to communicate (another constant).

In other words, although our physical environment or our outward expression and behavior fluctuate, our innermost needs—which are the drivers of change—do not. This is why Homer's *The Iliad* and *The Odyssey*, Shakespeare's *Hamlet*, and Strindberg's *Miss Julie* remain timeless and poignant: these works speak to our innermost (and oftentimes hidden) needs. They relate to values, such as love, respect, comfort, and so forth. No matter how much we seem to have changed, it can be argued that our basic needs do not. How fortunate we are to live in an age when technology is maturing to the point that it can offer services that fulfill these basic needs. The mobile location solution is just the sort of breakthrough that addresses needs through personal, customized services.

In this article, the author describes some of the driving forces behind mobile location solutions and introduces the main service categories and their target groups. He then gives an overview of Ericsson's technical solution, which allows operators to achieve immediate and 100% market penetration.

Figure 1
The mobile location solution has been designed to handle a variety of positioning methods and application interfaces.



Background

Mobile location solution (MLS) is Ericsson's name for a location system, including applications, that determines the geographic position of mobile subscribers and provides them with relational information and services (Figure 1).

In the early days of telecommunications, we called to a specific location in the hope that the party with whom we wanted to speak would come to the phone. With mobile telephony, however, we know to whom we are calling, but not necessarily his or her whereabouts. Other recent developments, such as the growth and development of information technology and databases (that is, the Internet and associated portals), have introduced completely new prerequisites for the use of information technology. Looking ahead, by combining positional mechanisms with location-specific information, we can offer truly customized personal communication services through the mobile phone or other mobile devices.

Driving forces

Legal aspects

In the USA, legal aspects have acted as the driving force behind GSM positioning standardization. The main player in this market has been the Federal Communications Commission (FCC). Organizations that represent fire brigades, hospitals and other emergency centers have also participated in formulating the FCC requirements. Authorities and industry have agreed on the pace and standards for positioning systems that will serve the market. The requirements have not been completely finalized, but an outline and characteristics have been specified: the FCC regulations differentiate between terminal-based (handset-based) and network-based solutions. A terminal-based positioning solution (Box B) relates to positioning intelligence that is stored in the terminal or its SIM card. These kinds of positional mechanism require a new terminal, a new SIM card, or both. In practice, this means that once the system has been installed, subscribers will have to replace their handsets or SIM cards to benefit from it. Market penetration will increase gradually as handsets and SIM cards are replaced over a period of, say, four to five years. Examples of terminal-based solutions are the network-assisted global positioning system (A-GPS), SIM

toolkit, and enhanced observed time difference (E-OTD).

By contrast, network-based positioning solutions (Box C) do not require positioning intelligence to be built into the handset (mobile terminal), which means that market penetration is 100% from the day the system or service is launched. Examples of network-based solutions include the cell global identity and timing advance (CGI+TA) and uplink time of arrival (UL-TOA) methods. Because terminal- and network-based positioning systems have different characteristics, the FCC has stipulated separate requirements for each. Today, the only methods that satisfy these requirements are the UL-TOA solution, which is representative of a network-based system, and the A-GPS solution, which is representative of a terminal-based system.

Commercial aspects

Outside the USA, the development of positioning systems is mainly driven by commercial considerations. These considerations, however, are every bit as strong as the legal aspects that drive the development in the USA. There are three main commercial reasons why operators would invest in positioning services:

- Differentiation—by adding positioning capabilities, operators can offer their subscribers new and attractive services. Operators who do so can compete from a more favorable strategic position.
- Reduced costs—operators who introduce positioning systems can optimize their networks to trace unsuccessful calls. With this information, they can adapt their networks (without waste or overdimensioning) to match calling patterns.
- Increased revenues—the potential of commercial services that use positioning information is truly infinite. What is more, professional and private subscribers are willing to pay for these services.

Location applications

Service categories

Location-based services are categorized by type of application.

Information services

Information services make use of an information bank where information is filtered according to the relative position of a user and the applications he or she has selected. Examples of information services include

BOX A, ABBREVIATIONS

A-GPS	Assisted GPS
BTS	Base transceiver station
CGI	Cell global identity
E-OTD	Enhanced OTD
FCC	Federal Communications Commission
GPS	Global positioning system
GSM	Global system for mobile communication
GUI	Graphical user interface
LMU	Location measurement unit
LCS-client	Location service client
MLS	Mobile location solution
MPC	Mobile positioning center
O&M	Operation and maintenance
OTD	Observed time difference
PLMN	Public land mobile network
RTD	Real time difference
SIM	Subscriber identity module
TA	Timing advance
TDOA	Time difference of arrival
TOA	Time of arrival
UL-TOA	Uplink TOA
WAP	Wireless application protocol

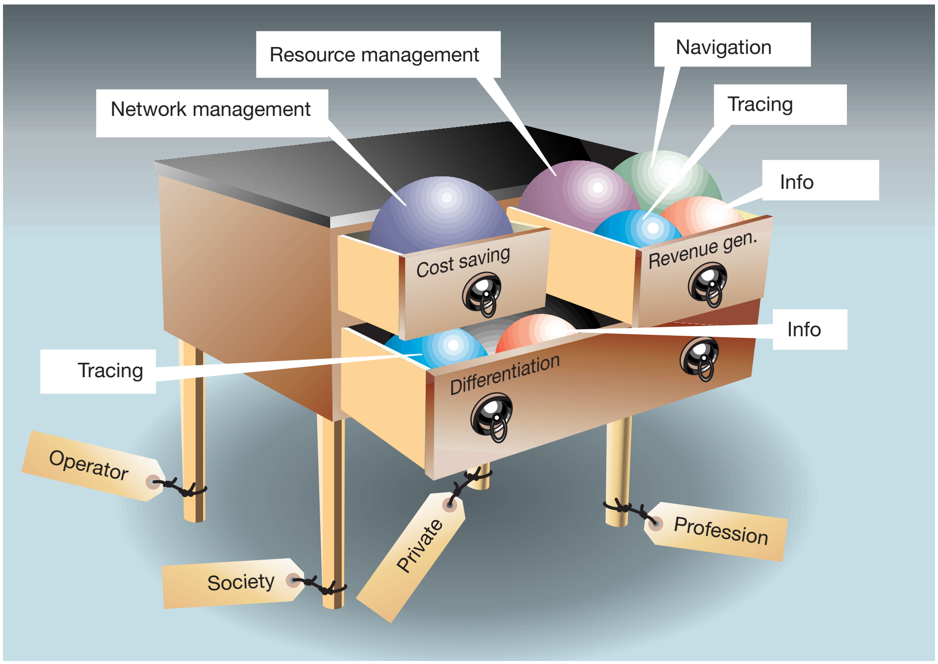


Figure 2
The chest of drawers illustrates how different applications can be grouped strategically for use by their beneficiaries.

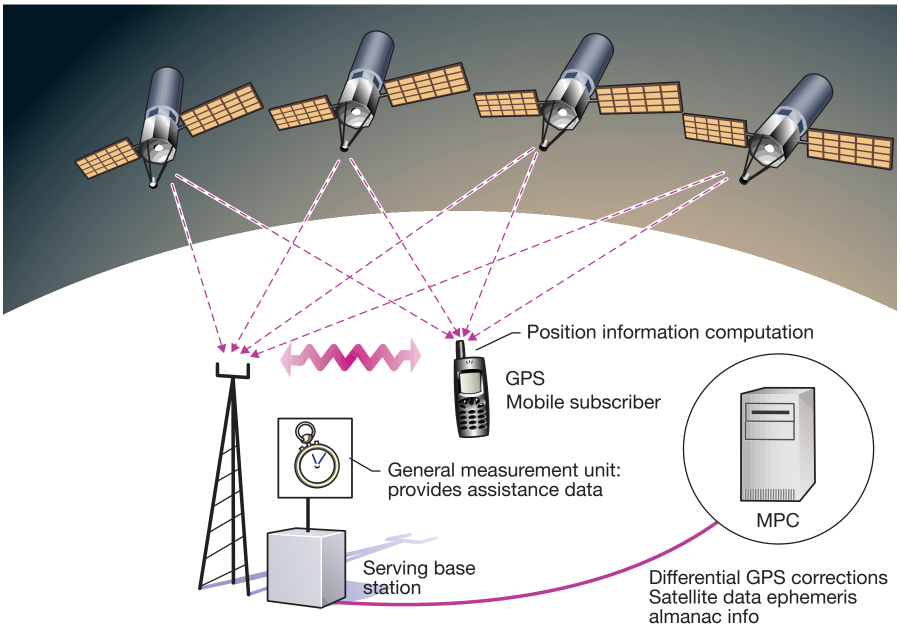


Figure 3
Compared to traditional GPS systems, network-assisted GPS (A-GPS) is a completely different product with very attractive characteristics.

location-based yellow pages, events, and attractions (for example, "What is happening today in town near here?")

Tracing services

Different services can use location-based information to trace mobile terminals (devices), to provide safety, to prevent theft, to facilitate delivery, and so on. Examples of this kind of service include the tracing of a stolen car, helping paramedics to locate persons quickly in an emergency situation, and giving a towing service or automobile repair shop the location of a motorist in need (out of gas, flat tire, dead battery).

Resource management

Resource-management applications are used to manage the logistics of vehicle fleets, freight, and service staff—for instance, repairmen with different skills and qualifications. Examples of resource management include taxi fleet management, the administration of container goods, and the assignment and grouping of railway repairmen.

Navigation

Navigation applications are used to inform subscribers how they can best move from point A to point B. Applications of this kind can be adapted to vehicle or pedestrian navigation.

BOX B, TERMINAL-BASED SOLUTIONS

A-GPS
The global positioning system (GPS) is commonly used for navigation purposes. Stand-alone GPS units are frequently found in cars, boats and airplanes. A GPS unit receives signals from four or more satellites. Each signal contains a time stamp and a description of the position of the satellite. By comparing this information, the GPS unit can calculate its own position. The main drawback of GPS is that satellite signals are relatively weak and may not always provide adequate coverage to all environments. However, the GSM network can provide assistance information that gives integrated GPS receivers better coverage than stand-alone GPS receivers (Table 1).

Different kinds of location measurement units (LMU) are used to collect assistance data. In order to provide satellite ephemeris and differential GPS correction, one LMU must be deployed every 300 km in the network. This enhancement provides accuracy within 10 or 20 m. To further increase the coverage of GPS (limited indoor coverage), a highly accurate time reference must be provided. However, this requires the deployment of one LMU in approximately every third BTS.

E-OTD
The enhanced observed time difference (E-OTD) method is based on the measured OTD between arrivals of bursts of nearby pairs of base transceiver stations. The mobile terminal measures the OTD. Synchronization and normal and dummy bursts can be measured. Since BTS transmission frames are not synchronized, the network must measure the relative time difference (RTD). To obtain accurate triangulation, OTD and RTD measurements are needed for at least three distinct pairs of geographically separate base station transceivers. Based on the measured OTD values, the location of the mobile terminal can be calculated in the network or by the mobile terminal itself, provided it has all the necessary information. The E-OTD method can be either:

- network-assisted, in which case the mobile terminal measures the OTD signal and computes its own location (to do so, the network must provide the terminal with additional information, such as BTS coordinates and RTD values); or
- handset-assisted, in which case the mobile terminal measures the OTD signal and reports its measurements to the network, which then computes the terminal's location. Accuracy is about 60 meters in rural areas and 200 meters in bad urban areas.

Table 1

Type of assistance	**Benefit**
Satellite ephemeris	Improves time-to-fix or sensitivity, or both, by focusing acquisition. Improves time-to-fix by eliminating the need to demodulate navigation messages.
Frequency accuracy	Improves time-to-fix by focusing acquisition.
Location estimate	Initializes the position computation procedure. Improves the acquisition of second and subsequent signals.
Differential GPS correction	Improves the accuracy of position estimates (10-20 m).
Time reference	Improves time-to-fix for all receivers. Improves sensitivity for receivers in poor signal environments.

BOX C, NETWORK-BASED METHODS

CGI+TA, enhanced CGI+TA
The single-cell timing-advance positioning method uses the cell global identity (CGI) and the timing advance (TA) parameter to determine the location of mobile terminals. The CGI identifies the cell in which the mobile terminal is located. A cell can be a circular or triangular sector. The TA parameter is an estimate of the distance (in increments of 550 m) from the mobile terminal to the base station. The measurement is based on the access delay between the beginning of a time slot and the arrival of bursts from the mobile terminal. The access delay is proportional to the distance between the base transceiver station and the terminal. The accuracy of this method varies according to the size of the cell. The radius of a cell may vary from 100 meters to 35 km (CGI). The width of an arc is 550 meters.

As seen in Figure 5, the CGI-TA positioning method is merely an enhancement of the CGI. The estimated location is reported in terms of longitude, latitude, and an uncertainty shape within which the mobile terminal is located.

Researchers are currently investigating ways of improving the accuracy of the CGI+TA method; this enhanced technique uses the CGI+TA method as a base in its positioning determination. Test results indicate a granularity of between 100 and 200 meters.

Uplink time of arrival (UL-TOA)
The uplink TOA positioning method is based on measuring the time of arrival of a signal from a mobile terminal to four or more measurement units. Ideally, the signal is a training sequence of a random access burst but it could also be a normal burst. The UL-TOA positioning method works with all existing mobile terminals—that is, no handsets need to be modified. Location measurement units (LMU) located at the base stations receive the bursts and measure the value of the uplink time of arrival (UL-TOA). The mobile position center (MPC) calculates the time difference of arrival (TDOA) by subtracting pairs of UL-TOA values.

Prerequisites for calculating position by means of the UL-TOA positioning method are as follows:

- The geographical coordinates of the measurement units are known.
- The timing offset between the measurement units is known—for instance, by the use of absolute GPS time at the measurement units, or by using reference measurement units (also referred to as reference terminals) to determine the real time difference (RTD).

The MPC delivers a position estimate and an uncertainty estimate to the application. The accuracy of this method varies according to the environment and the number of location measurement units employed. Accuracy typically varies between 50 (rural) and 150 meters (bad urban).

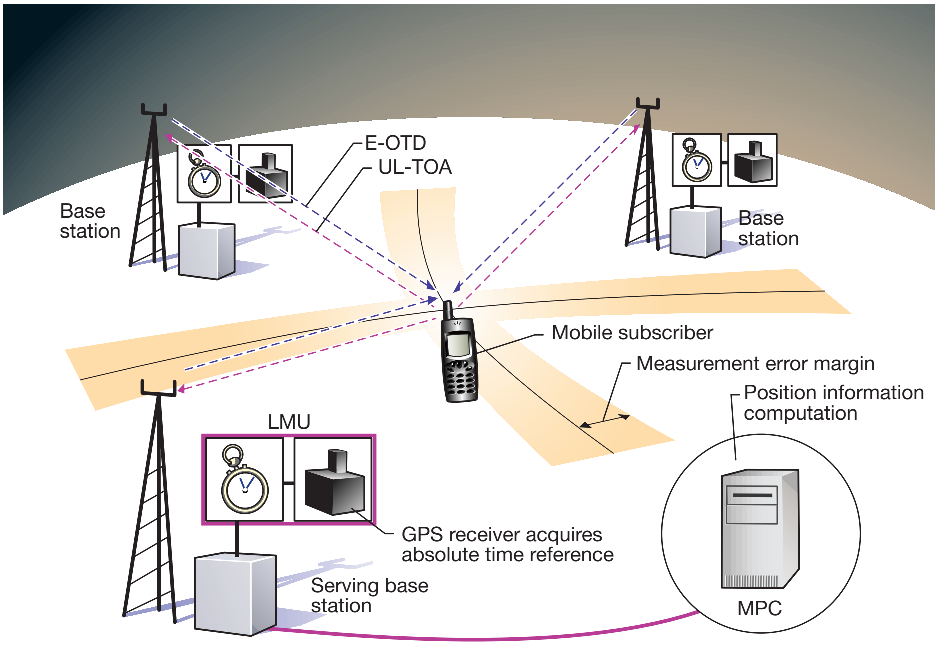


Figure 4
Although they measure in different directions, the UL-TOA and E-OTD methods each use the triangulation of time difference between base stations and the terminal to determine positions.

Other services

Some positioning applications, such as network planning, map services and telematics, do not fall into the above categories. Examples of these services include hot-spot tracing ("How is my network used?"), and location-based charging.

Target groups

It is interesting to note that the characteristics of location-based services apply equally well to commercially driven and legally driven developments—their application categories address some of mankind's most basic needs, including safety, comfort, and the need to communicate. Moreover, because these needs are so basic, they apply to all four target groups.

- Society's (government) interest in location-based services stems from its role as a provider of safe and equitable environments for its citizens.
- Operators want to introduce location-based services into their networks because they create revenue, cut costs, and project a positive business image to the market.
- Professional end-users are attracted by the efficiency with which location-based services enable them to manage their resources. These services also function as marketing amplifiers, since location-related information is, by nature, already very specific and can readily be adapted to specific customer groups. Some professional end-users resell location-based services directly to the end-user.
- Private end-users want location-based information and services because they tend to heighten the user's overall sense of comfort and well-being—truly personalized services match customers' requests according to their profile, location, and time of day.

About positioning systems

System principles

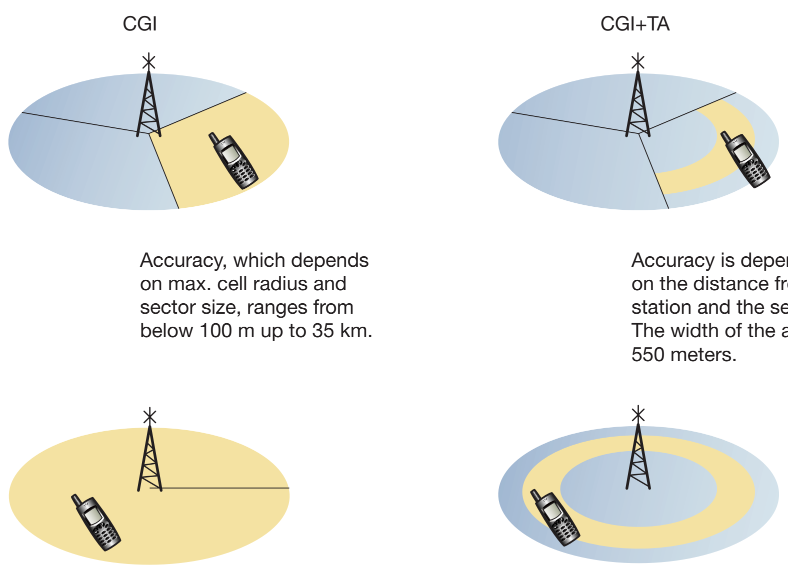
There are two kinds of positioning system:

- overlay systems; and
- integrated systems.

Overlay systems are built on top of an existing network system. Since they use few core network features, these systems can be implemented in mixed networks. However, because overlay systems will not be standardized, they are neither future-proof nor does their design meet legal requirements. In summary, the market window for overlay systems is very short—this window will close when the standardization work has been completed.

Once the standards have been finalized, it

Figure 5
The CGI+TA solution (which offers 100% market penetration) can serve as a fall-back method, provided the preferred positioning method fails to determine the position of the mobile terminal.



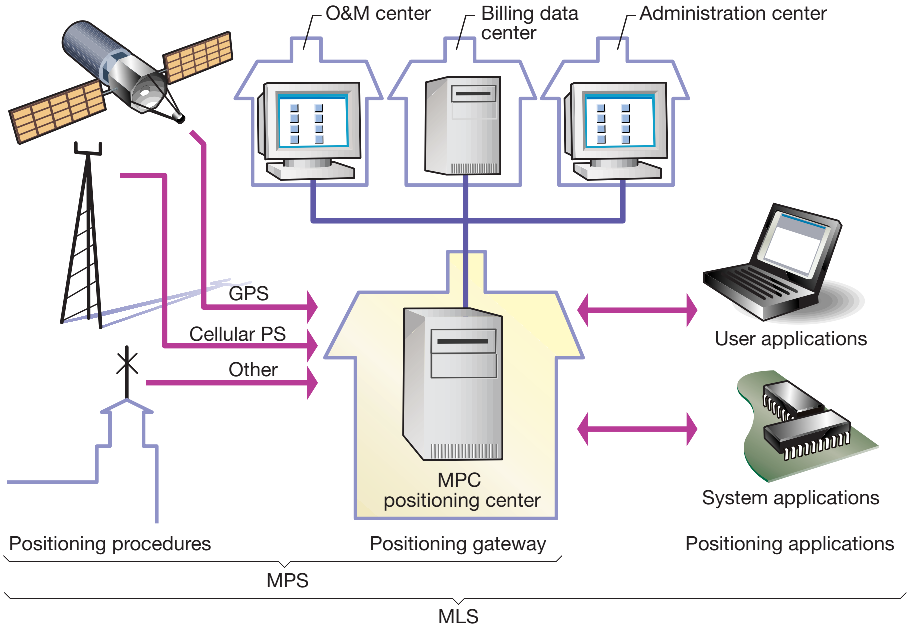


Figure 6
Overview of Ericsson's mobile location solution (MLS). A mobile positioning system has been logically integrated into the network.

will be possible to launch any compliant network-based solution in any network. What is more, the network-based solutions have been designed

- to meet legal and commercial requirements; and
- to follow the GSM evolutionary roadmap toward third-generation systems.

Standardization

The CGI+TA and UL-TOA positioning techniques were standardized in May 1999, and plans have been made to standardize the E-OTD and A-GPS positioning techniques during the first quarter of 2000. The SIM-toolkit positioning solution will not be standardized.

The Ericsson solution

Ericsson's mobile positioning system consists of three logical subsystems.

1. The positioning subsystem can use a variety of techniques to determine and supply geographic coordinates:
   - the cellular positioning system; for example, UL-TOA and E-OTD;
   - the network-assisted global positioning system (A-GPS);
   - other techniques, such as the SIM tool-kit.
2. The positioning gateway subsystem (MPC), which functions as a mediation device between the public land mobile network (PLMN) and the location service client (LCS-client), retrieves data from positioning subsystems (such as the E-OTD) and converts it into positioning information for the LCS-client. It also provides the operator with a GUI (based on a Java platform) for administering the node—in the Ericsson solution, this node is called the mobile positioning center tool (MPC-tool).
   Note: because the MPC is a mediation device, it monitors and can register the usage of specific location applications, thereby allowing operators to charge for them via applications installed in the MPC or via interfaces to the billing system. This is not the case when traditional global positioning systems are used. In those systems, the network solely serves as a link for transporting positioning data between the terminal and the central application-

Figure 7
New generations of terminals will provide an unprecedented quality of information in an easy-to-use, "pick-and-choose" fashion.

management site. Therefore, operators or service providers cannot charge specifically for their service.

3. The LCS-client, which is a subsystem of the MLS, contains applications that make use of positioning information. Internal applications (for instance, emergency calls) are coded into the GSM system according to the GSM standard. External applications are supplied to the system by system vendors, the operator, and third-party application developers. Some applications might even be "interactively customized" by the end-user.

Market impact

The demand for services

Can we—by determining the driving forces behind mobile location solutions, the beneficiaries of their services, and the probable number of service categories—judge the extent to which mobile positioning systems will succeed? No. These exercises merely suggest which needs the systems and their services might fulfill. The market impact of MLS services is determined by the end-users' willingness to pay for them.

By means of the Internet, WAP technology, portals, and so on, we are being inundated with information. The challenge at hand is to filter this information to make it practical for use by the man or woman in the street. Modern society demands instantaneous service that has been tailored to fit individual or group needs. The service must take into account the end-user, the group to which he or she belongs, and where he or she is located at any given moment. These are, in fact, the very things that Ericsson's mobile location solution does: it selects information and, with the help of WAP technology, serves it up to the end-user through an easy-to-use, interactive interface (Figure 7).

Market potential

In a report issued by OVUM Ltd., the global market value of MLS between 1999 and 2005 is expected to reach USD 25 billion. Today, there are some 200 million GSM subscribers, and this number (including next-generation GSM) may well reach one billion by 2004. Using this information, let us project a simple forecast of our own: A basic directory service costs USD 0.50 per request. Assuming that 400 million subscribers will use the service 20 times a year, the service will generate an annual revenue

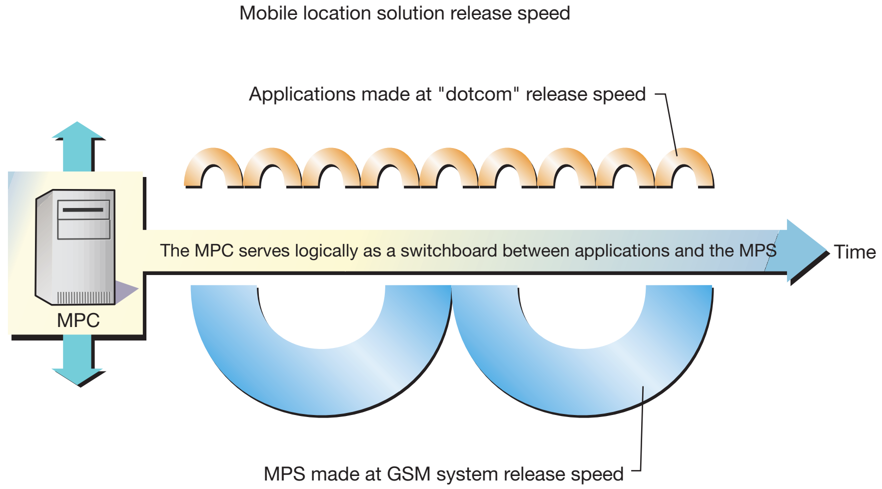


Figure 8
The design of Ericsson's mobile location solution allows developers to create applications independently of the mobile positioning system. This ensures system reliability and guarantees that services can be customized rapidly.

of USD 4 billion. Thus, would not a more advanced yellow-pages service have the potential to generate even more revenue?

Ericsson's strategy

Given the tremendous potential of MLS, both for consumers and the industry, vendors must ensure that their products meet market demand in terms of matching services, timing (time to market), quality, and long-term compatibility. To determine what these demands are, Ericsson has taken an active, leading stance toward MLS, by pushing the standardization work ahead, and by becoming the first vendor of a cellular positioning system.

Maximum revenues are achieved by rapidly changing the product line-up that meets the demands of short-lived market windows. This is achieved through a ready-to-go packaging of standard services and by allowing service providers or third-party service vendors to customize and develop new services. To this end, Ericsson's MLS employs alternative location mechanisms that give subscribers a range of positioning techniques from which to choose, as well as a best-effort technique (provided the requested positioning technique is unavailable). The system is easy to manage and includes "top-notch" billing capabilities. A service portfolio ensures that subscribers receive the right services at the right time (Figure 9).

Conclusion

Mobile location solutions, which combine mobile location systems and location-specific services, represent the next major "killer application" of the mobile industry. Early estimates put the value of the market at USD 25 billion, but given the tremendous demand, these estimates are probably conservative.

The five main service categories for location-based services are information services, tracing services, resource management, navigation, and "other services"—those services that do not fall into one of the first four categories.

The four main target groups of location-based services are government, operators, professional end-users, and private end-users.

Ericsson's mobile location solution has been designed to offer high-end network-assisted (A-GPS) and network-based cell-identity (CGI+TA) positioning techniques, to give operators immediate and 100% market penetration in a future-proof environment.

TRADEMARKS